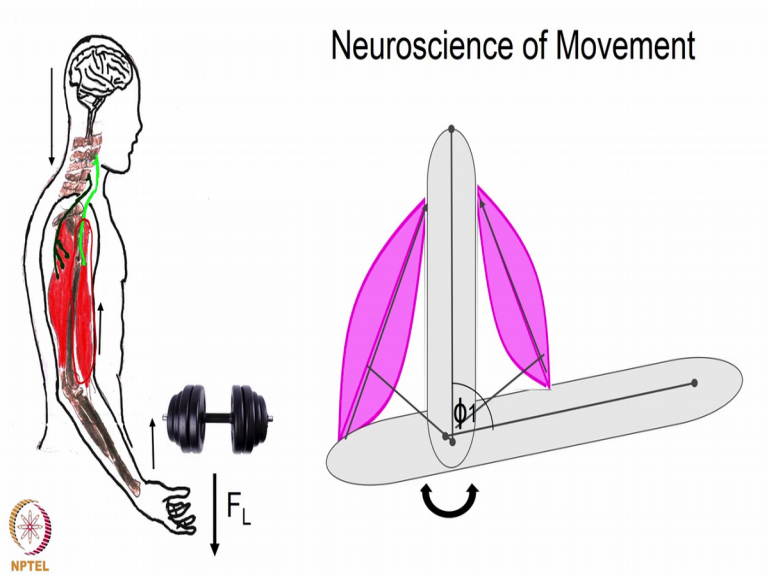
Neuroscience of Human Movement
Department of Multidisciplinary
Indian Institute of Technology, Madras
Neuroscience of Human Movement

Lecture – 01
Neuroscience of Human Movement

Welcome to this class on Neuroscience of Human Movement. This is the 1st class of this course and in this class; I will be introducing the various concepts that are going to be taught in this course. So, essentially this is a class in which we will discuss the syllabus for the course.

(Refer Slide Time: 00:36)

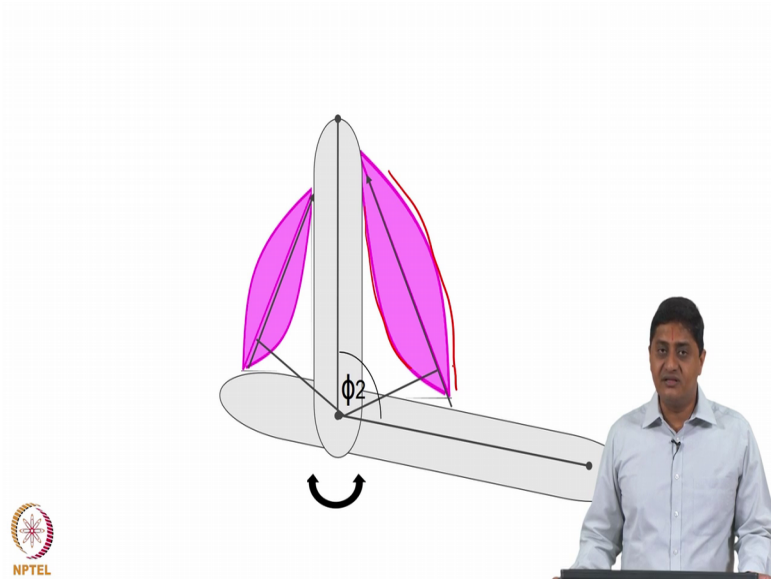


So, this is a course on Movement Science or Movement Neuroscience. So, consider a simple case in which a person wants to lift weight, right. For example, I am having this dumbbell and I would like to perform this bicep curls, this exercise. I would like to perform this exercise. How do I lift this external mass? Note if I was not lifting this, the object will fall down. So, essentially I am producing a non-zero force to keep this object in equilibrium and when I am moving, I may be producing a different force to move this object. So, how do I do this simple task that is the question.

This can be considered to be movement of two rigid bodies related to each other. So, essentially when I am doing that exercise, my forearm is moving relative to my upper arm, right. So, the underlined rigid bodies are the bones without going into the details of

which bone, this is which muscles are responsible. We will just look at this as two rigid bodies moving related to each other causing a movement. So, human movements essentially imply movement of one segment of the body relative to another segment of the body.

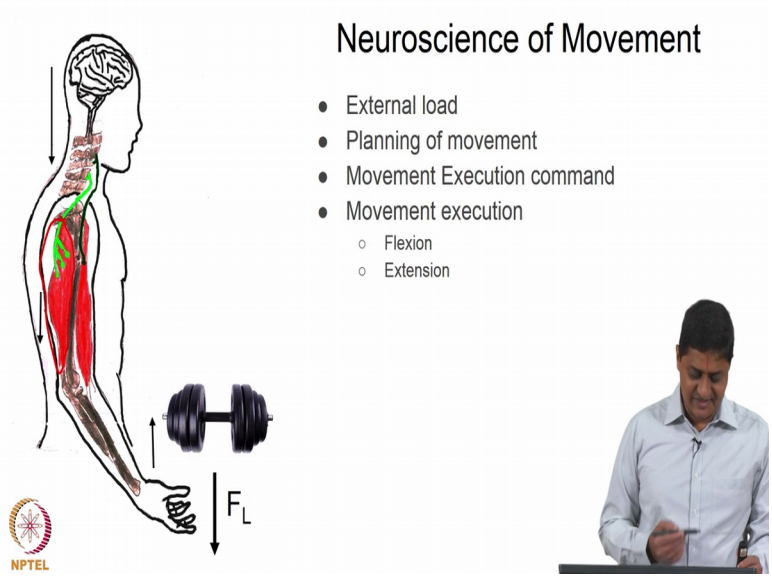
(Refer Slide Time: 02:00)



Suppose I am doing that for example in that case, the angle between that and that which was earlier, that means say 90 degrees now has reduced this movement is called fluxion and suppose I am doing the opposite, right. In this case, the angle has increased from 90 degrees.

Any case in which the angle increases can be called as extension and the case in which the angle between the segments decreases or reduces can be called as fluxion, simple definition for this purpose of this class, right. So, these movements are performed by muscles. What are shown in pink here are muscles and these muscles when they contract, they produce this relative movement between bones.

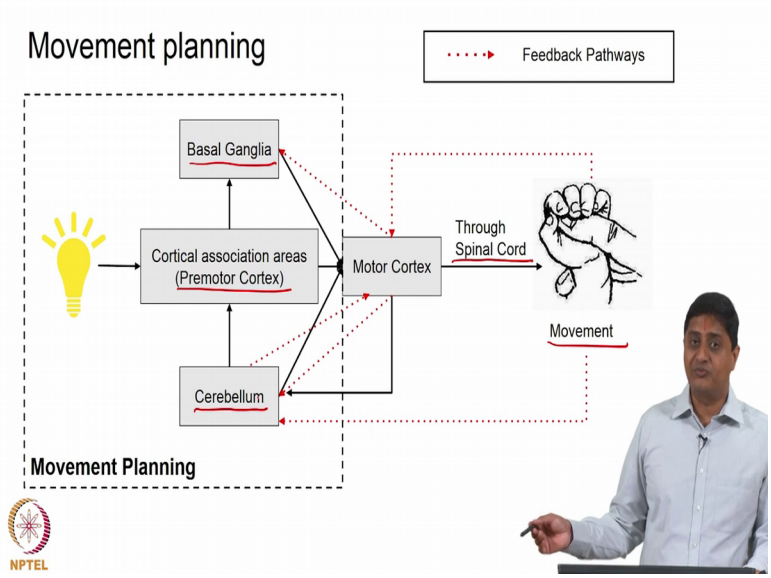
(Refer Slide Time: 02:58)



Whenever you say that there is a production of a force, that means there is a force generated that is there, is it not how is this force generated, that is one question. That is something we will discuss as part of the course, and this muscle is receiving inputs from neurons in the spinal cord. These are shown in black here, right. Neurons in the spinal cord, the two muscles are receiving inputs from neurons in the spinal cord. So, these neurons communicate with the muscles. The question is how does the neuron communicate with the muscle? Also spinal cord itself receives information from the brain, right. So, when I have to perform voluntary movement like in the case of dumbbell lifting that I just now did, I am trying to do that. For me to do that there is a planning of movement, there is region in the brain that is responsible for planning and executions of movements. How does that happen?

So, shown here are two brain regions responsible for modulating movements. Here is Cerebellum and this is one part of Basal Ganglia.

(Refer Slide Time: 04:18)



So, essentially what appears as movements are muscle contractions that produce relative movements between body segments right. That is what is seen by us as movements and these muscle contractions themselves are controlled by the spinal processes, right or spinal cord receives inputs mainly from motor cortex. It also receives inputs from red nucleus, reticular formation, vestibular nucleus etcetera, but mainly from motor cortex and the motor cortex itself consults other regions of the brain such as association areas, premotor cortexs which bring in appropriateness or context to the movements and basal ganglia which is probably responsible for action selection, reinforcement, motor learning etcetera, reward related motor learning and cerebellum which is implicated in timing of movements, error correction, long term or short term error correction or motor learning etcetera.

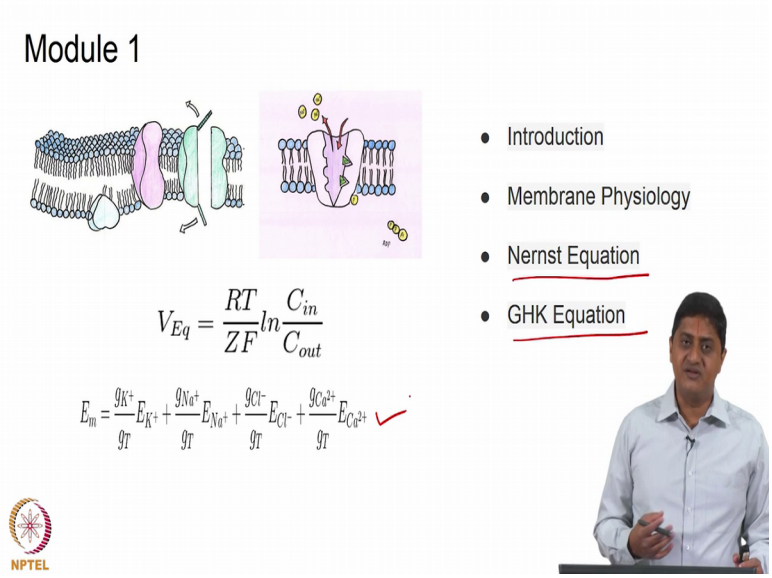
Note, cerebellum and basal ganglia communicate with motor cortex and motor cortex communicates with the spinal cord. Cerebellum and basal ganglia do not directly project to the spinal cord, important point to note. So, let us go back to the case of performing bicep curls or lifting the dumbbell, performing this exercise, right. In this case, at least two muscles are responsible for producing these movements.

So, neurons from the spinal cord innervate these muscles, right. For example, when you want to perform fluxion, right so there is planning of movement and execution command from probably reaches the muscle through the spinal cord, right like that for flexion and

that muscle contracts. So, that produces a flexion action like that, right. Now, suppose I want to perform at different movement or the opposite movement, then what happens at different muscles are that muscle is recruited, right and neurons that innovates that muscles are activated again through brain processes through spinal processes and that produces this kind of movement. So, muscles produce force. How does the muscle generates force is one topic that we will discuss how does neuron communicate with the muscle to generate that force, how much the system decide how much force to produce, right?

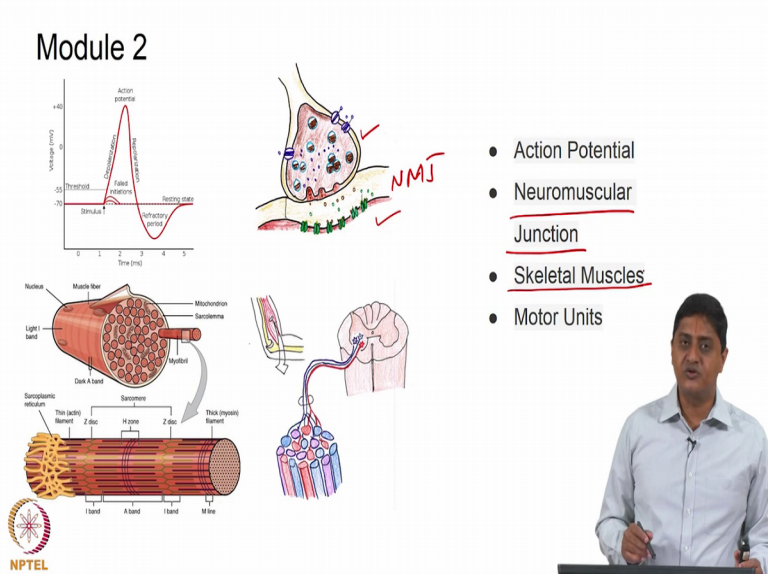
Neuro muscular communication is of interest for us and these neurons communicates with themselves are receiving inputs from higher centres called brain centres. How do these brain centres make decisions? Essentially movements are manifestations of decisions what the brain processes that underlie this decision making, right. So, what to expect out of this course?

(Refer Slide Time: 07:49)



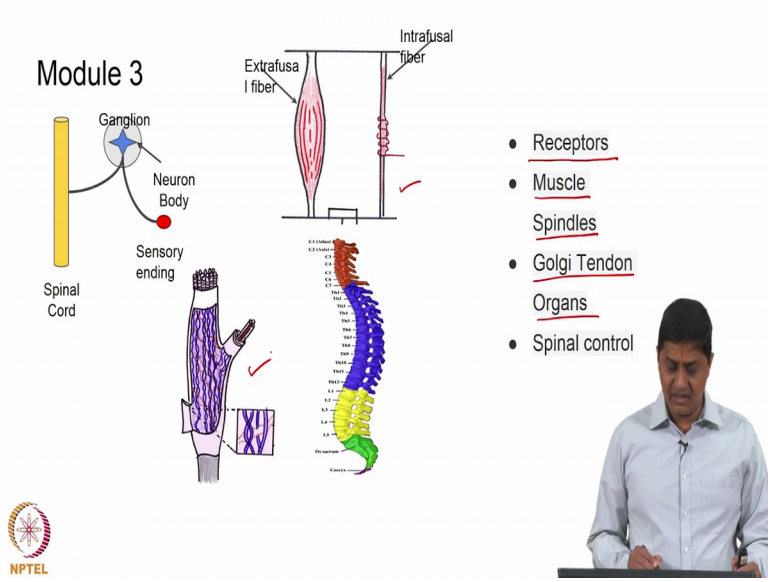
So, we start the case of the biological membrane and how in excitable cells, there is a study membrane potential and topic related to the maintenance of this membrane potential, such as Nernst equation, GHK equation and here you have Chord Conductance Equation, right. So, this is Membrane Physiology that forms the foundation of communication between x a double cells.

(Refer Slide Time: 08:19)



Then, in module 2 it talk about generation of action potential that is responsible for communication between the x a double cells and how neurons and muscles communicate with each other. So, this is the case of neuromuscular junction and alpha motor neuron and all the muscles fiber innovator by it are collectively called as by motor unit and how does the motor unit function and how are motor units recruited.

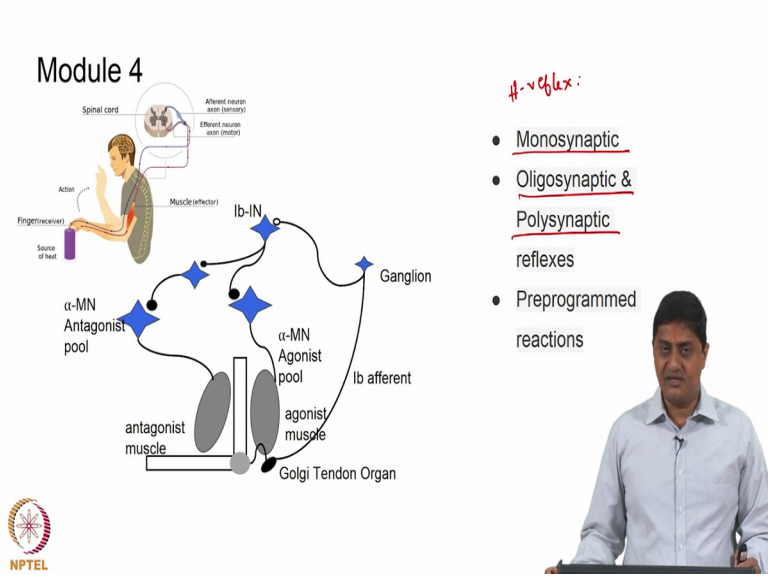
(Refer Slide Time: 08:51)



In module 3, we will talk about final processes specifically we are interested in receptors, specific kind of receptors called prop receptors. Examples of these are Muscle Spindles

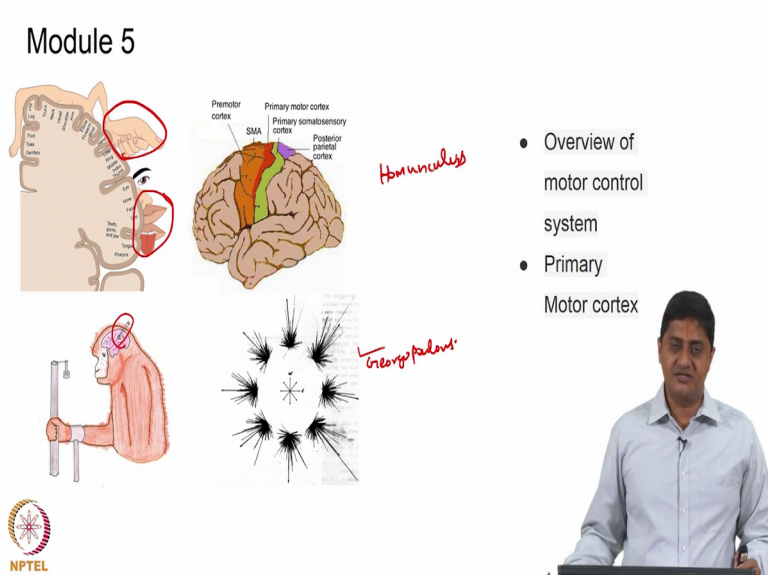
and Golgi Tendon organs, right. So, these are Muscle Spindles and these are Golgi Tendon organs.

(Refer Slide Time: 09:11)



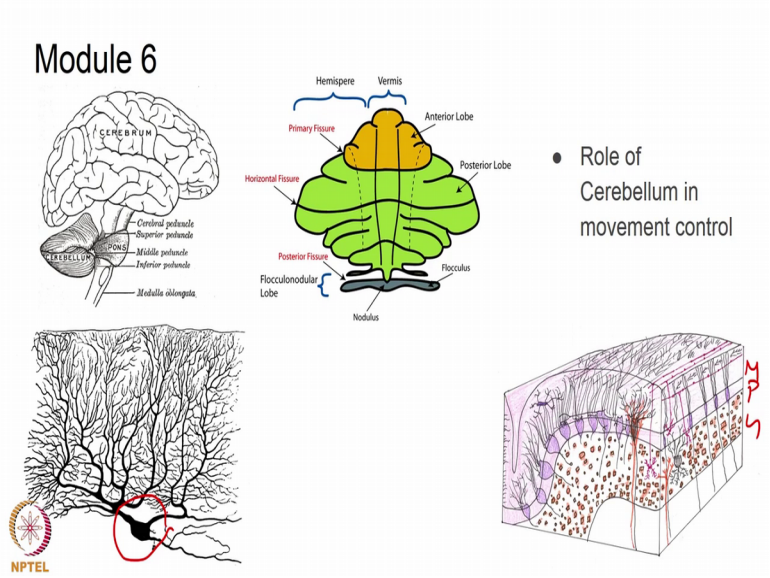
In module 4, we are interested in other spinal processes and reflexes. So, here what is given is an example of an oligosynaptic Ib reflex, but we will also be discussing monosynaptic reflexes including H reflex and we will also be discussing pre-program reactions, right or triggered reactions.

(Refer Slide Time: 09:38)



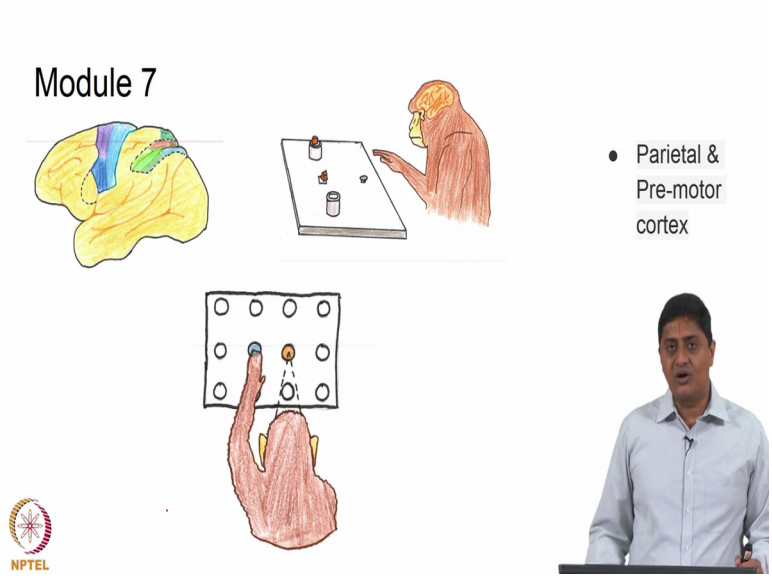
In module 5, we will start our discussion Primary Motor Cortex and how does the Primary Motor Cortex make its choices, right what are the various things that the Primary Motor Cortex consider as important magnitude of movement or direction of movement etcetera. Several methods concerning the study are also discussed in relatively great detail. For example, here Intra cortical micro electro recordings and what is shown here results from the group of Georgopoulos. We will also be discussing how different region of the body receive different amounts of inputs from the motor cortex. So, essentially what you are seeing is a disproportionate representation of the hand and finger region and the face in this so-called little manner homunculus, right. So, we will be discussing this Homunculus concept.

(Refer Slide Time: 10:50)



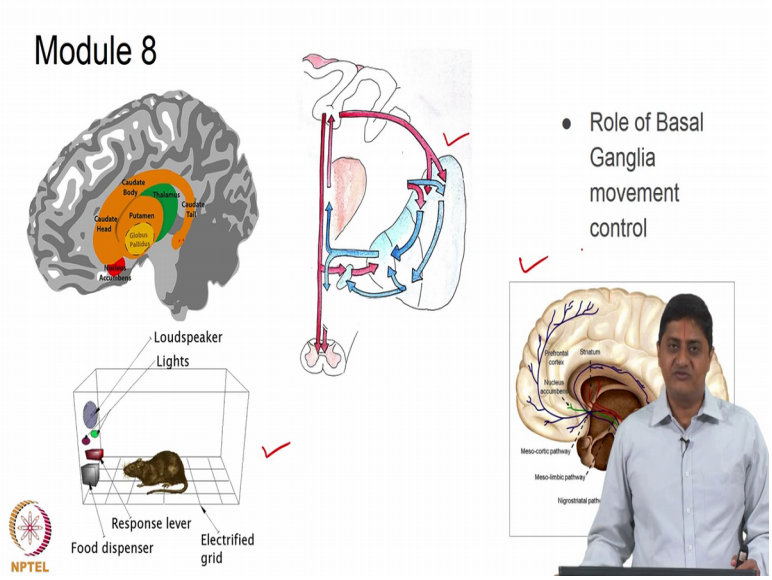
In module 6, we will be discussing cerebellum and how cerebellum plays an important role in modulating movements, right and we will be discussing Anatomy Physiology. So, we will discussing various layers, Molecular layer, Purkinje cell layer and the Granular layer. Here is Purkinje cells and its dendritic tree shown in.

(Refer Slide Time: 11:11)



In module 7, we will be discussing Parietal and Pre-motor cortex and how Parietal and Pre-motor cortex bring in context are appropriateness to the movements.

(Refer Slide Time: 11:21)



So, in module 8 we will be discussing Basal Ganglia, its role in movement selection and other reward related behaviour for example, right. So, what is shown here is reward related experiment there and the pathways, inhibitory and excitatory pathways are shown, the direct, hyper direct and indirect pathways are shown here and structure

responsible are shown here for example and here, right. So, with this we come to the end of this lecture. We will continue our discussion in future classes.

Thank you very much for your attention.